Theoretical and Mathematical Physics 2012 vol.173 N2, pages 1604-1619

Microscopic model of a non-Debye dielectric relaxation: The Cole-Cole law and its generalization

Khamzin A., Nigmatullin R., Popov I.
Kazan Federal University, 420008, Kremlevskaya 18, Kazan, Russia

Abstract

Based on a self-similar spatial-temporal structure of the relaxation process, we construct a microscopic model for a non-Debye (nonexponential) dielectric relaxation in complex systems. In this model, we derive the Cole-Cole expression for the complex dielectric permittivity and show that the exponent α involved in that expression is equal to the fractal dimension of the spatial-temporal self-similar ensemble characterizing the structure of the medium and the relaxation process occurring in it. We find a relation between the macroscopic relaxation time and the micro- and mesoparameters of the system. We obtain a generalized Cole-Cole expression for the complex dielectric permittivity involving log-periodic corrections that occur because of a discrete scaling invariance of the fractal structure generating the relaxation process on the mesoscopic scale. The found expression for the dielectric permittivity can be used to interpret dielectric spectra in disordered dielectrics. © 2012 Pleiades Publishing, Ltd.

http://dx.doi.org/10.1007/s11232-012-0135-1

Keywords

complex dielectric permittivity, dielectric relaxation, discrete scaling invariance, fractal, log-periodic oscillation, non-Debye dielectric spectrum